Primary Germ Layers

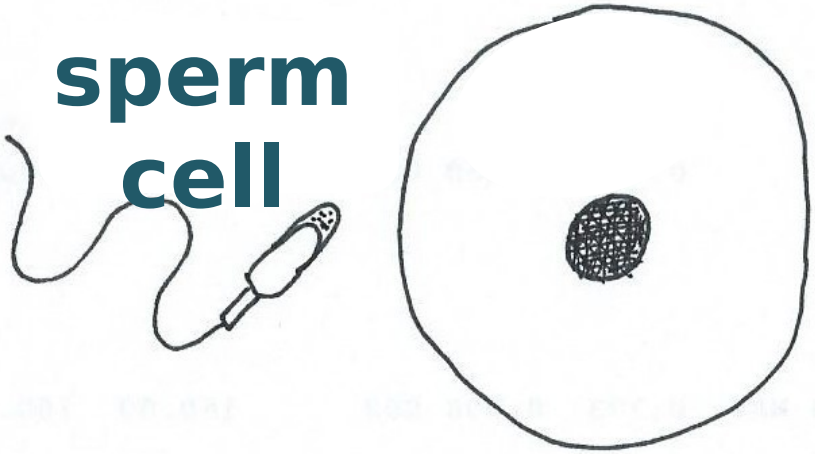
Germ layer – a collection of cells formed during embryogenesis (reproductive) development.

Humans have **3 primary germ layers** called the **endoderm**, **mesoderm** and **ectoderm** (triploblastic).

They are named from where they derive from.

Germ layers give rise to **all tissues** and organs.

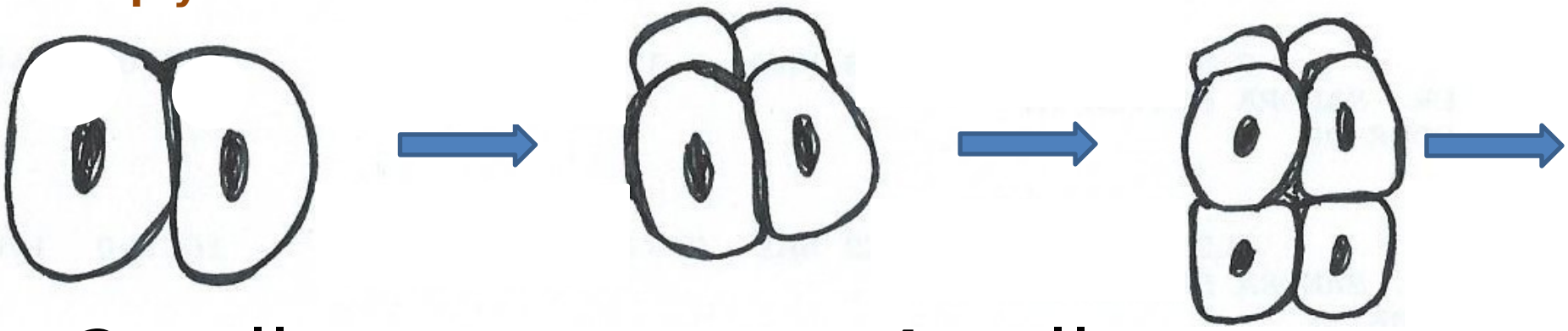
sperm cell



egg cell

When the egg cell is fertilized = a **zygote**

Then the cells begin to multiply . . .



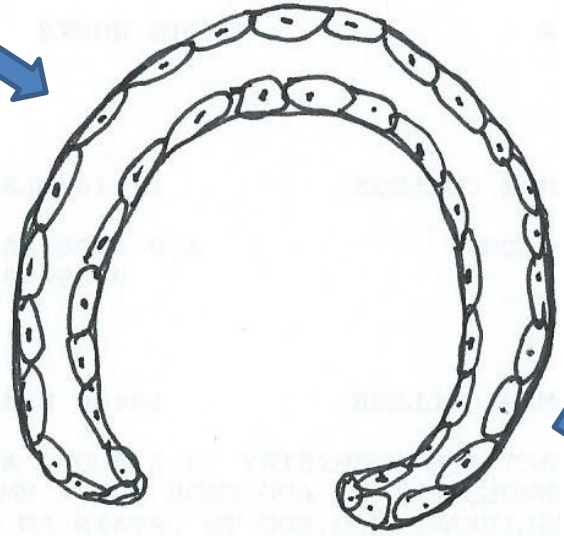
2 cells

4 cells

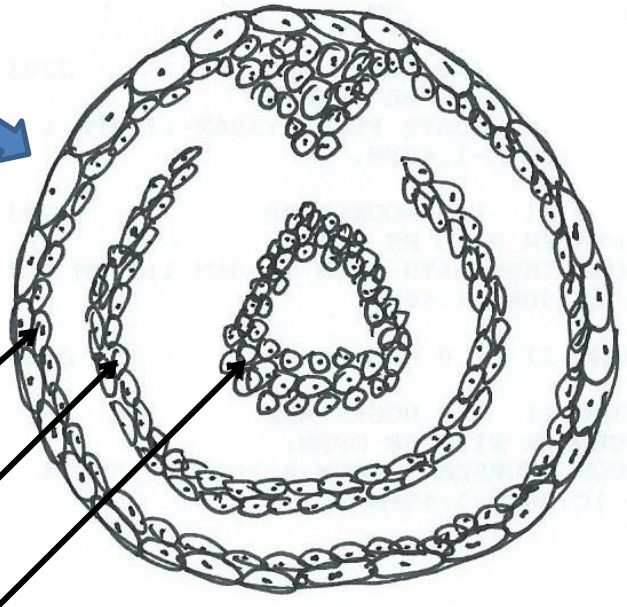
8 cells

The 3 Primary Germ Layer
of the Embryo (Yolk Sac)

Blastula



Gastrula



Embryo

Ectoderm

Mesoderm

Endoderm

The Three Primary Germ Layers

The three **primary (1°) germ layers** in the body are named depending on where in embryological development they derive from. The cells in each of these layers differentiate into the cells of each of the four (**4**) **primary tissues** of the body.

Table below shows some specific tissue generated from the 3 1° Germ Layers

Endoderm	Mesoderm	Ectoderm
Entire G.I. tract, Respiratory tract (pharynx, larynx, trachea, lungs) Lining of urinary bladder, and urethra Lining of auditory canal, tonsils, thyroid, parathyroid, thymus, Liver and pancreas	All Connective tissue: (from blood to bone) Most all Muscle Tissue: Skeletal, Cardiac, Smooth Endothelium of blood vessels, lymphatic vessels, body cavities, joint cavities, Dentin of teeth Kidneys and ureters Adrenal cortex Internal reproductive organs	Epidermis of skin and epidermal derivatives: hair, nails, glands skin; Linings of oral, nasal, anal, and vaginal cavities All Nervous tissue, special sense organs Enamel of teeth Pituitary gland Adrenal medulla Lens of eye

Tissue = a group of cells and cell products with similar structure and function.

There are four 1° tissues in the body:

1) Epithelium

2) Connective

3) Muscular

4) Nervous

A. Functions of Epithelial Tissue

1) Physical Protection

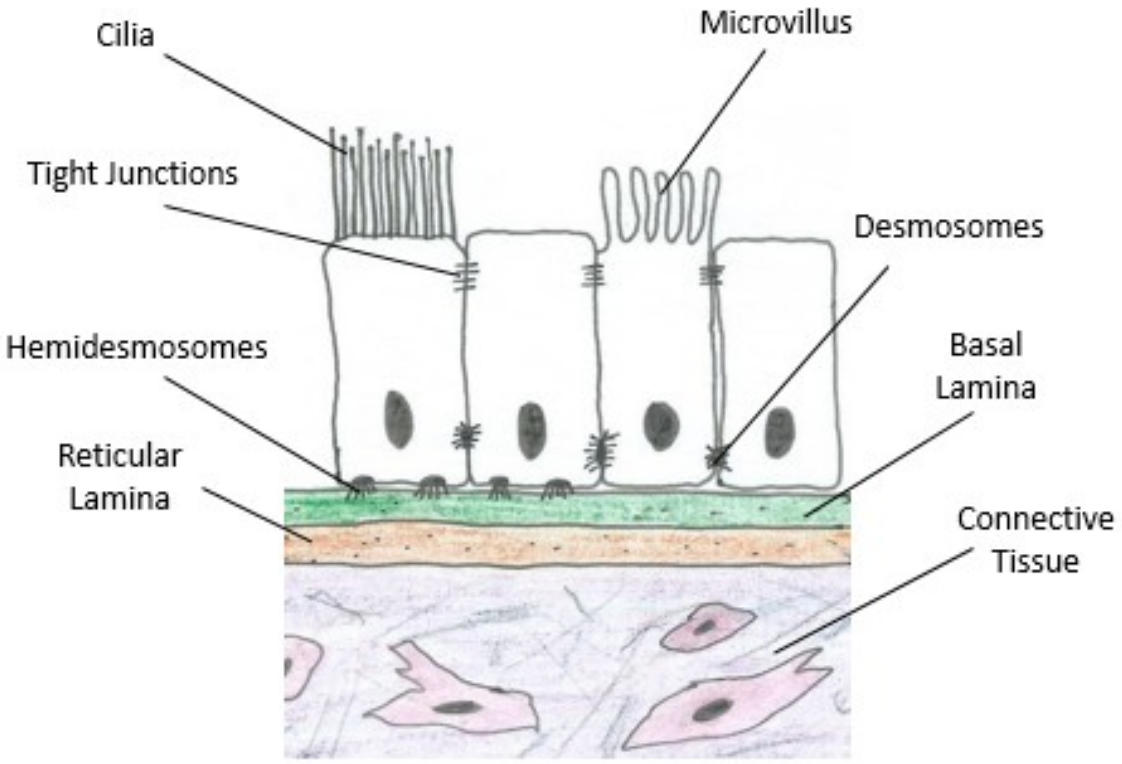
2) Regulate Exchange

3) Provides Sensation

4) Produce Secretions

B. Characteristics of Epithelial Tissue

1) <u>Cellularity</u> – Most of this tissue is comprised of cells, with very little extracellular material. This tissue looks like a 'wall of cells'.



2) <u>Polarity</u> – Epithelial tissue has a 'sidedness' to it. There is a superficial or **apical** surface (exposed), and a bottom or **basal** surface, attached to basement membrane.

Apical end specializations: **a) Cilia** or **b) Microvilli**.

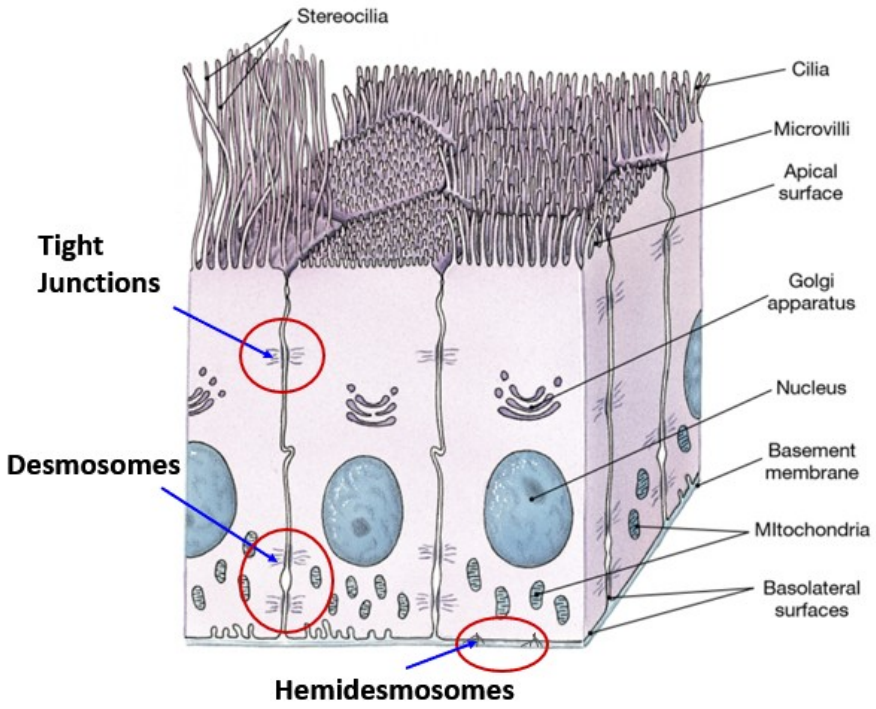
3) <u>Attachments</u> – Cells in epithelial tissue are physically connected to the cells adjacent to them, including above and below, as well as being attached to the **basement m**

a) Tight Junctions

b) Desmosomes

c) Hemidesmosomes

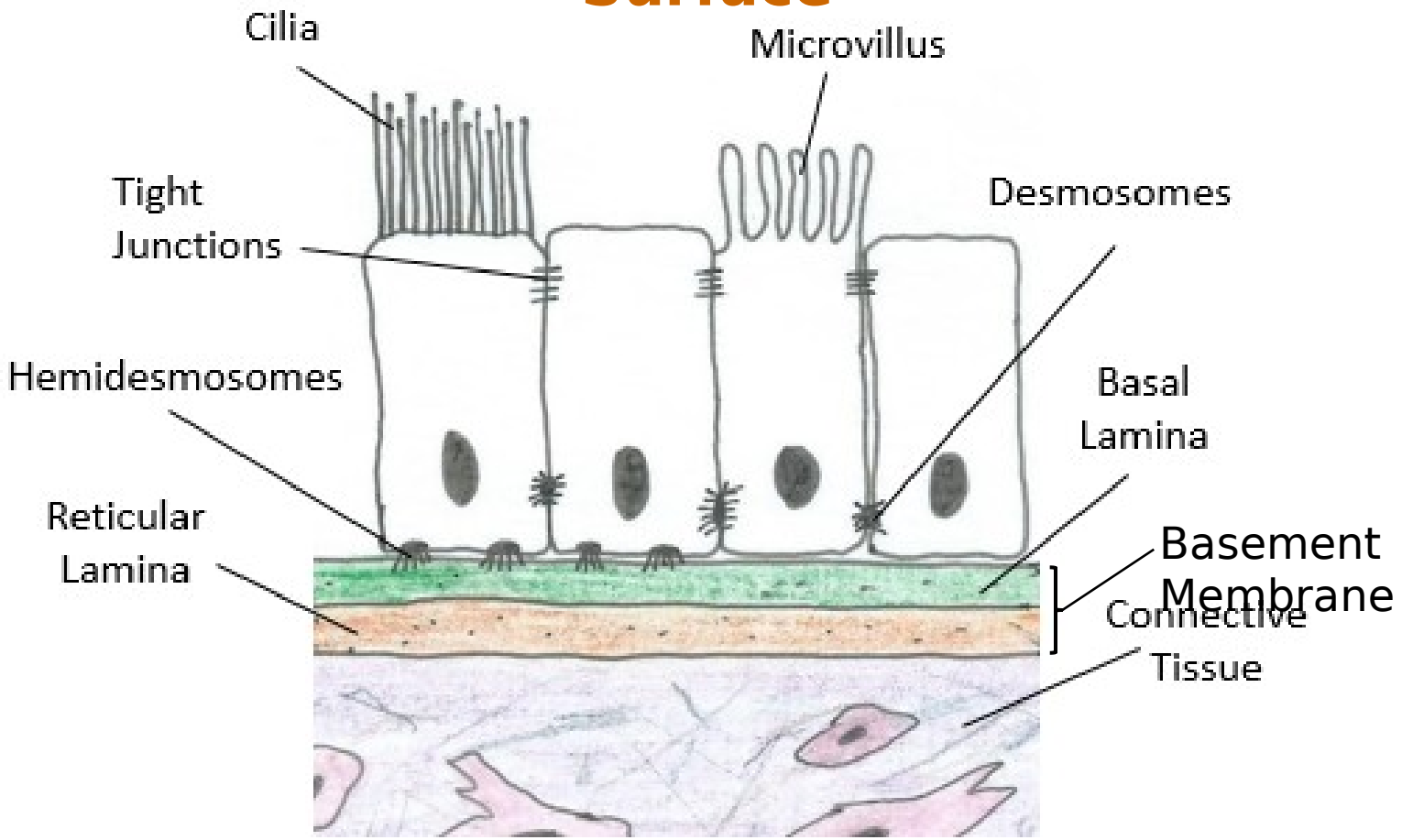
d) *Gap Junctions*



4) <u>Avascularity</u> – Epithelial tissue does not have any blood vessels within it, thus it has no direct blood supply of its own. A = without, and vascular = blood, together meaning 'without a blood supply'. This limits how many cell layers can living in this tissue.

5) <u>Highly Regenerative</u> – Epithelial tissue has a high capacity to make

Exposed (Apical) Surface



Anchored (Basal) Region

Classification of Epithelia

1. Number of cell layers

A) Single layer of cells = **Simple Epithelium**

B) Several layers of cells (more than one) = **Stratified Epithelium**

2. Shape of Exposed (apical) cells

Squamous epithelium - Thin and flat.

Cuboidal epithelium - Short cube-shaped hexagonal boxes.

Columnar epithelium - Taller than it is wide.

Transitional epithelium - Changes shapes (from squamous to cuboidal).

Classification of Epithelia

Simple (only 1 cell layer)

1) Simple Squamous Epithelium

Glomerular capsule; Alveolus
Mesothelium; Endothelium

) Simple Cuboidal Epithelium

Renal tubules;
Thecal follicle (thyroid gland)

) Simple Columnar Epithelium

Stomach, Small and Large Intestines

) Pseudostratified Ciliated Columnar Epithelium

Trachea, larynx, bronchi

Stratified (more than 1 cell layer)

5) Stratified Squamous Epitheliu

Keratinized = Epidermis of skin
Non-keratinized = esophagus, cheek

6) Stratified Cuboidal Epithelium

Ducts of sweat glands
Ducts of salivary glands

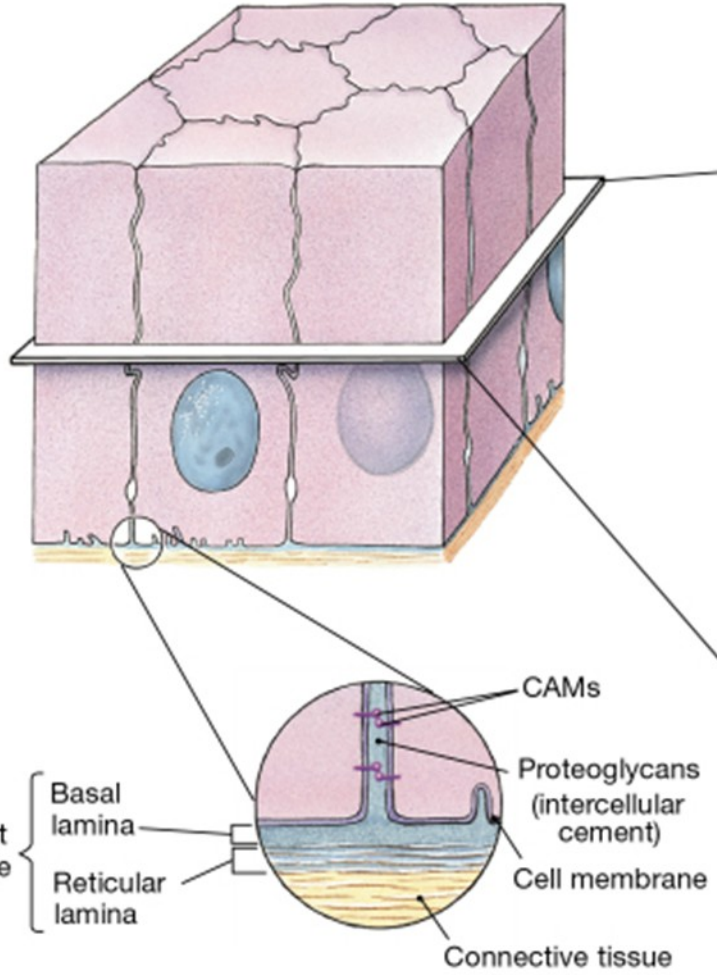
7) Stratified Columnar Epithelium

Male urethra
Conjunctiva of the eye

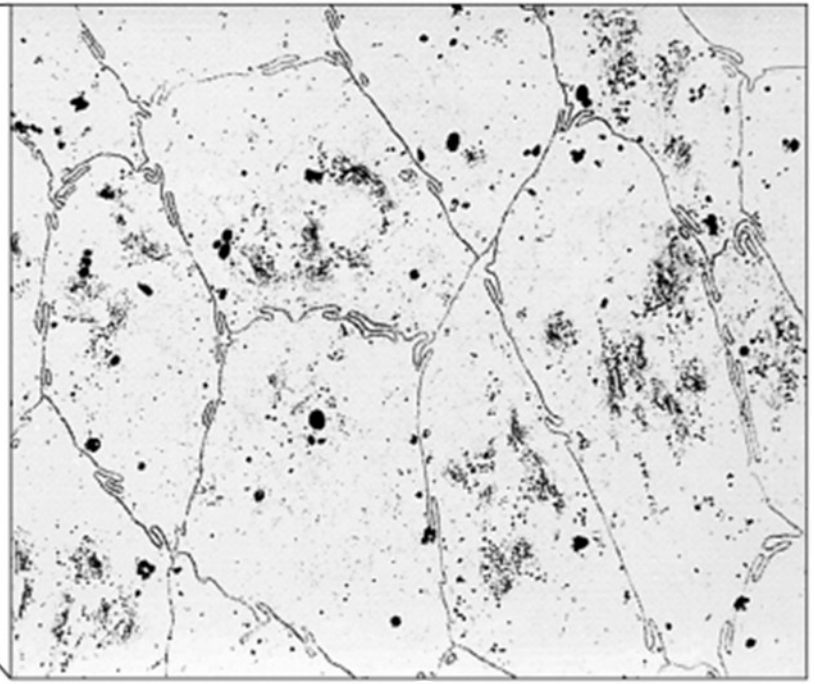
8) Transitional Epithelium

Ureter
Urinary bladder
Urethra

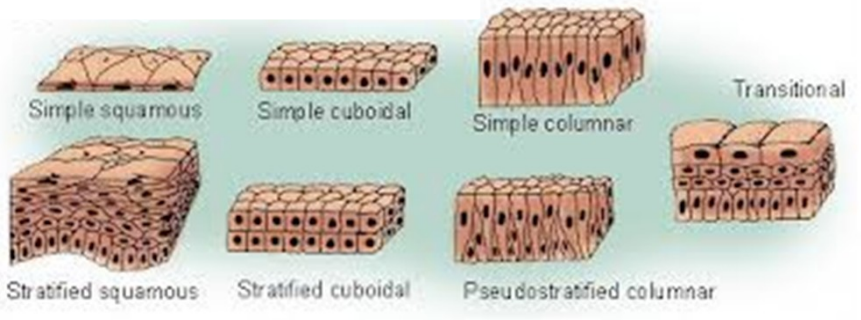
3-D Epithelial Tissue



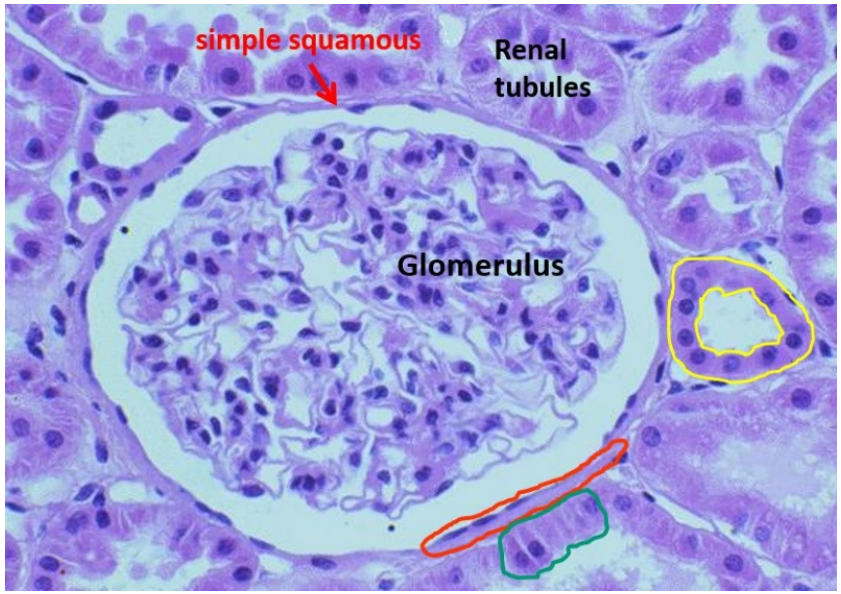
Epithelial histology (top View



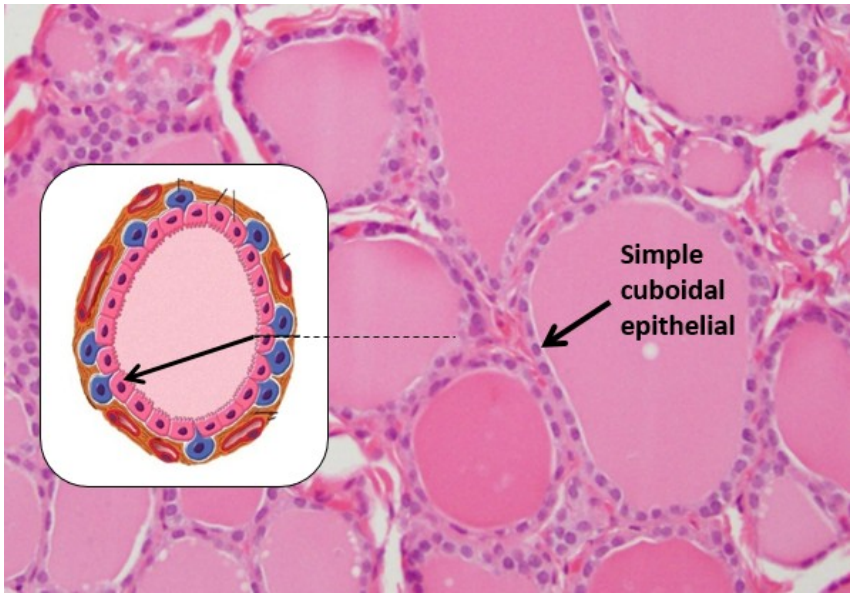
Types of Epithelium



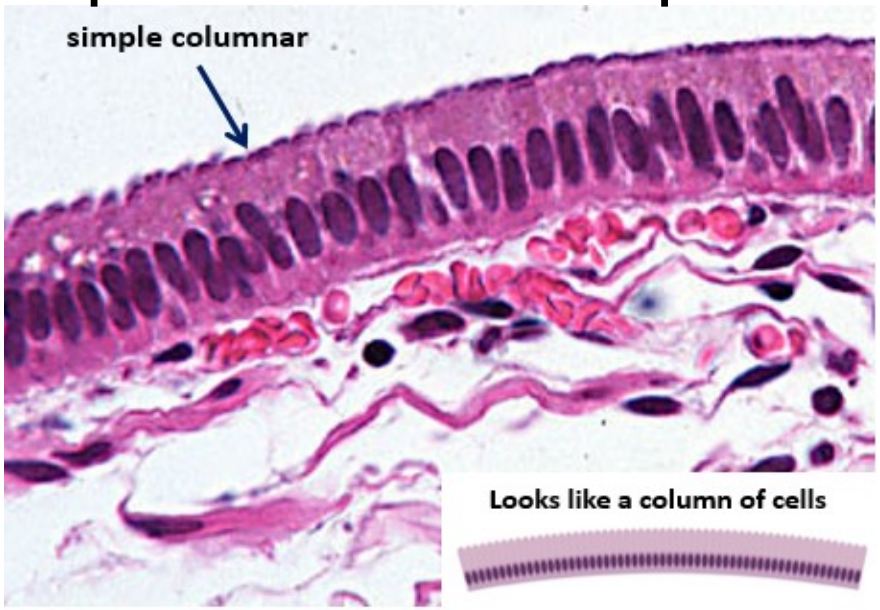
Simple Squamous Epithelium



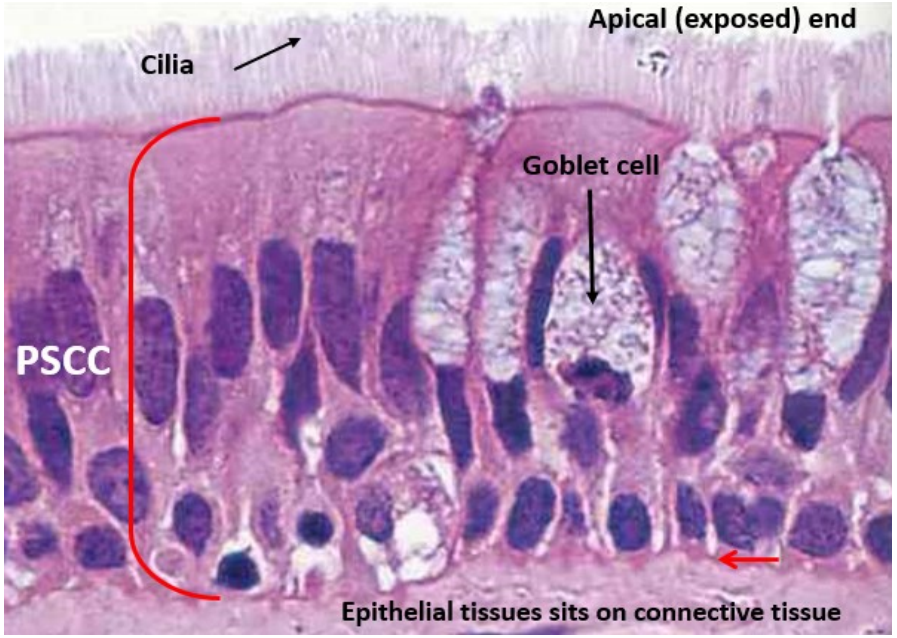
Simple Cuboidal Epithelium



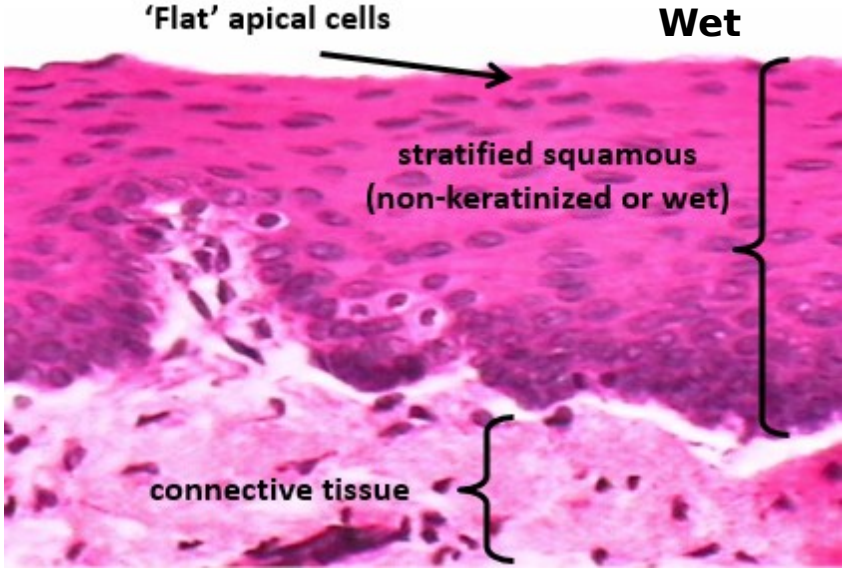
Simple Columnar Epithelium

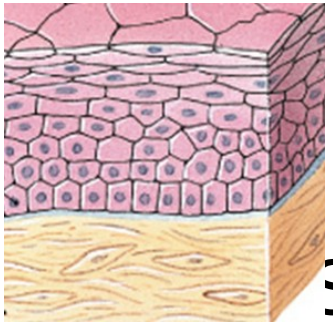


Pseudostratified Ciliated Columnar Epithelium

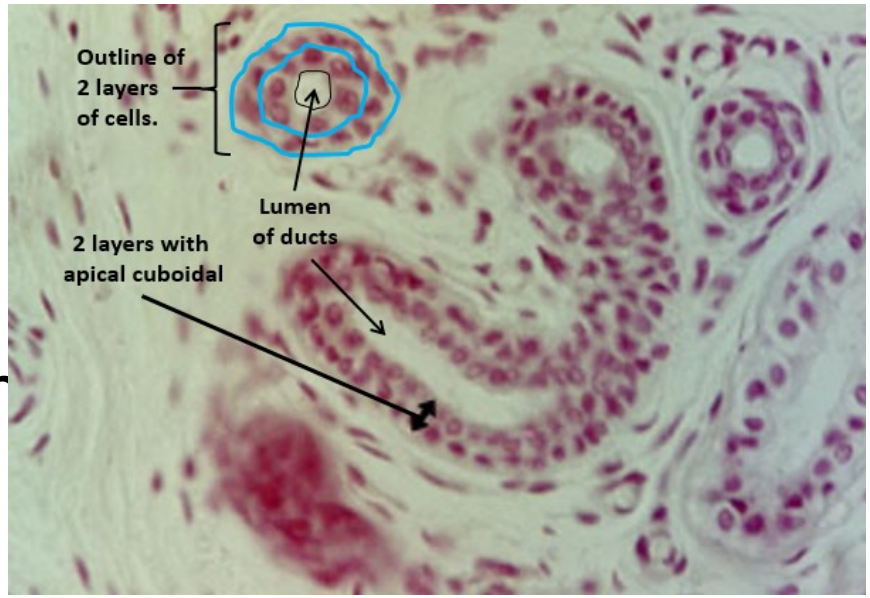


tratified Squamous Epithelium

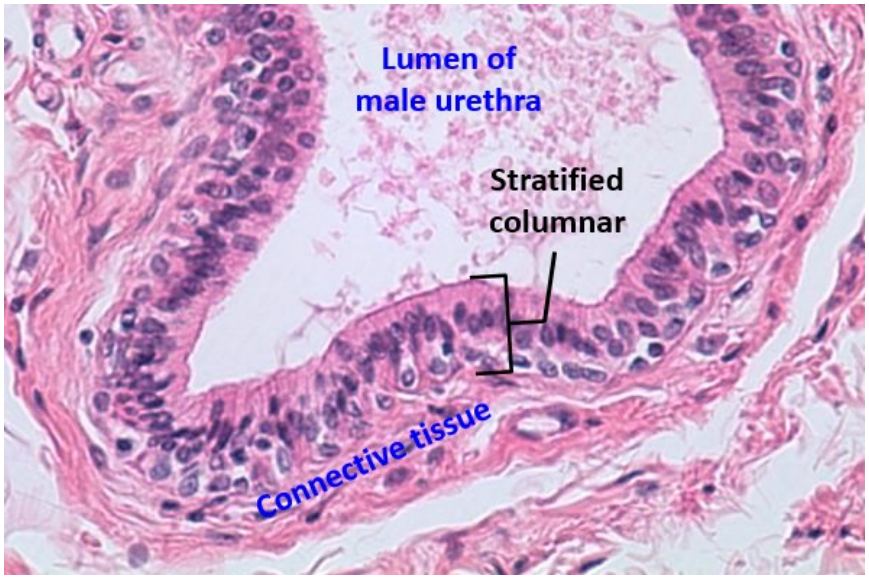




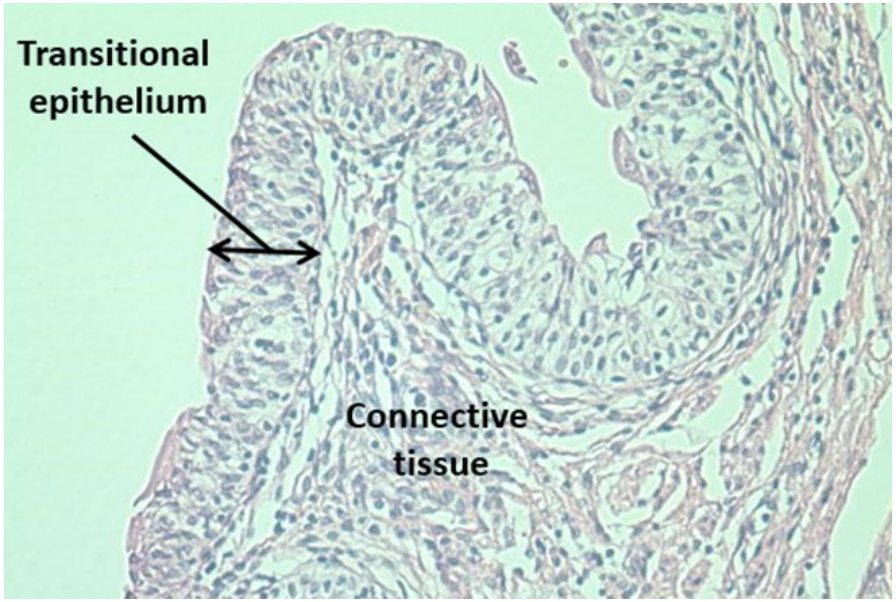
Stratified Cuboidal Epithelium



tratified Columnar Epithelium



Transitional Epithelium



The 3 Elements of Connective Tissu

1. A variety of Cell types

2. A variety of Protein/Fibers

3. Various Ground Substances

1. Cells of Connective Tissue

1) Fixed cells, fibroblasts, adipocytes, chondrocytes, chondroblasts, osteocytes, osteoblast.

2) Wandering cells, like macrophages, mast cells, erythrocytes and leukocytes.

2. Fibers in Connective Tissue:

1) Collagen: thick, strong and unbranched (most common is type I collagen).
White in body, stains pink and blue in histology.

2) Reticular: very thin (type III collagen), fine, branching ('network') and flexible.

3) Elastic: medium thickness, from elastin, often seen in coils.
Yellow in body, stains dark in histology.

3. Ground Substance of Connective Tissue:

Most common components of connective tissue ground substance are: **1) Hyaluronic acid**, and **2) Glycosaminoglycans** (Mucopolysaccharides).

Plus: **Chondroitin sulfate** is found in all cartilage tissue, it's responsibly

A.Functions of Connective Tissue

1) **Structural Framework** – For internal interconnecting, packing, binding tissues.

2) **Protection** – Insulates vital organs (skull, rib cage, adipose), buffers and cushions internal organs (areolar and reticular) cover and bind many organs.

3) **Storage within Body** – Adipose stores energy (as triglycerides or fats). Bone stores minerals calcium and phosphate, plus many trace minerals in its calcified matrix.

4) **Transportation** – Blood and lymph fluids transport material through the body.

5) **Repair and Healing** – CT is the ultimate ‘fallback’ tissue for healing and making repairs in body. Any gap or injury is filled by CT. Scar tissue usually result of ‘back-filling’ with collagen fibers when a wound is deep or significant.

B. Characteristics of Connective Tissue

1) Abundance of Extracellular Material – Most cells in CT are not closely packed (like epithelium). The fibers and ground substance exist in various proportions and arrangements.

Note: *The main difference between *loose* and *dense* connective tissue is how densely packed the matrix is with fibers.

2) Various Specialized Cells – The cells are versatile in size, shape and function, depending on the specific type of CT (they are not 'consistent' as in epithelium).
Many cell types in CT continue to *differentiate* (e.g., osteoblasts become...).

3) Blood Supply Varies – Some CT is richly vascularized, e.g., bone, adipose and areolar. Other tissue is moderately supplied, e.g., dense irregular and reticular CT. Some are scantly supplied, e.g., dense regular (tendons and ligaments). Finally, all cartilage (hyaline, elastic and fibrocartilage) are avascular (no direct blood supply).

4) Nervous Innervation – All CT has nervous innervation (supplied by nerves) but most connective tissue is not very richly innervated,

Connective Tissue

Fluid Connective Tissue

1) Blood
2) Lymph

Connective Tissue Proper

Loose
1) Areolar
2) Adipose
3) Reticular

Dense
1) Regular
2) Irregular
3) Elastic

Supporting Connective Tissue

Cartilage
1) Hyaline
2) Elastic
3) Fibrocartilage

Bone
1) Spongy
2) Compact

Connective Tissue

Fluid Connective Tissue

Blood – in blood vessels and heart.

Lymph – in lymph vessels and lymph nodes.

Connective Tissue Proper

Loose

1) Areolar - Papillary region of dermis, around blood vessels, C.T. of membranes.
2) Adipose - Hypodermis, eye sockets, renal fat capsule.
3) Reticular - Spleen, lymph node, capsule of liver and kidney.

Dense

1) Regular – Tendons, ligaments.
2) Irregular – Joint capsules Reticular region of dermis.
3) Elastic – Elastic ligaments, walls of arteries, penile ligaments.

Supporting Connective Tissue

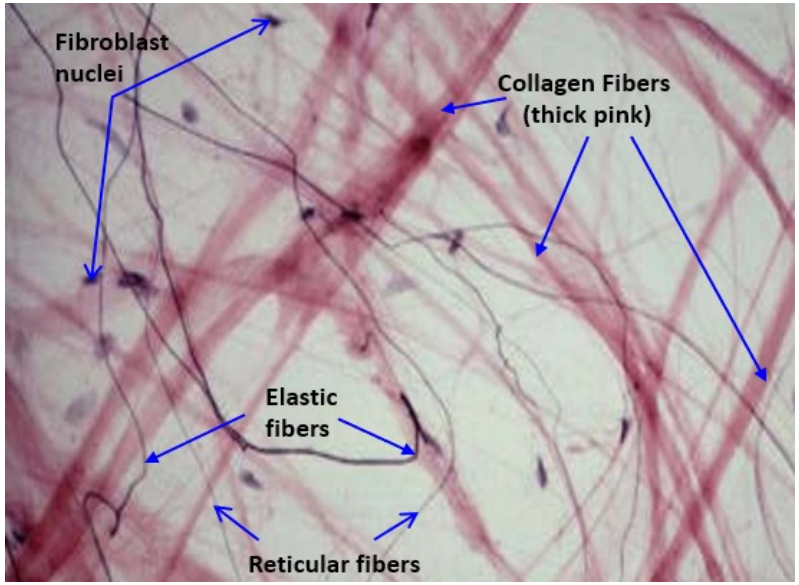
Cartilage

1) Hyaline – nose, trachea, larynx, Costal cartilage, articular cartilage.
2) Elastic – epiglottis, external

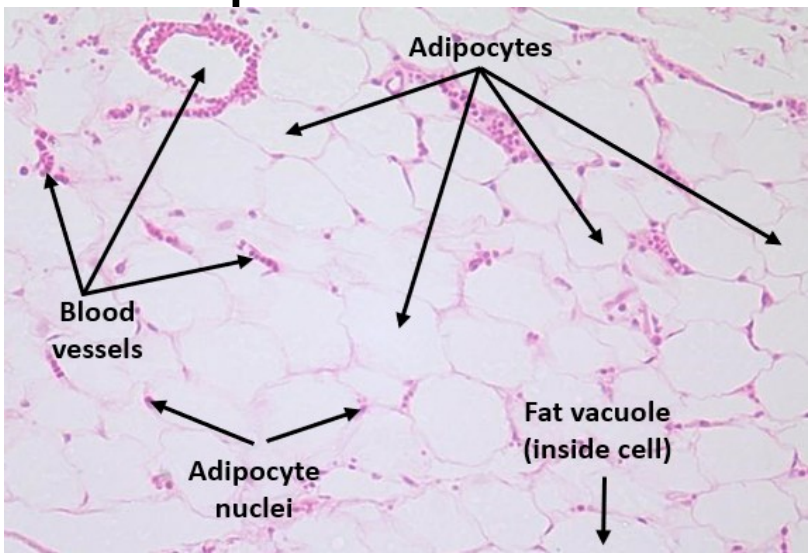
Bone

1) Spongy – inner portion.
2) Compact – outer portion.

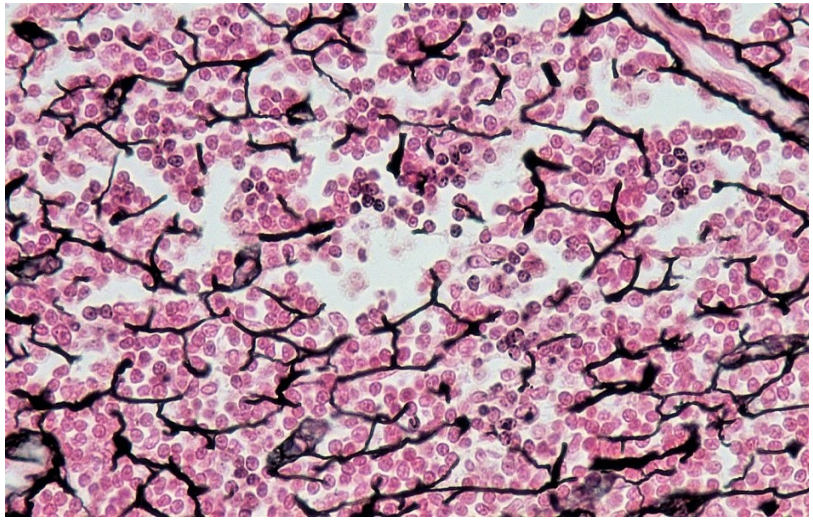
Areolar Tissue



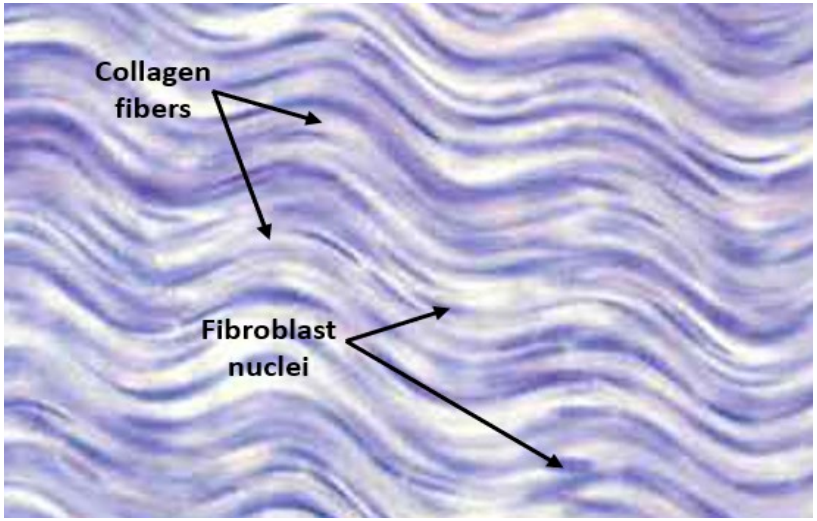
Adipose Tissue



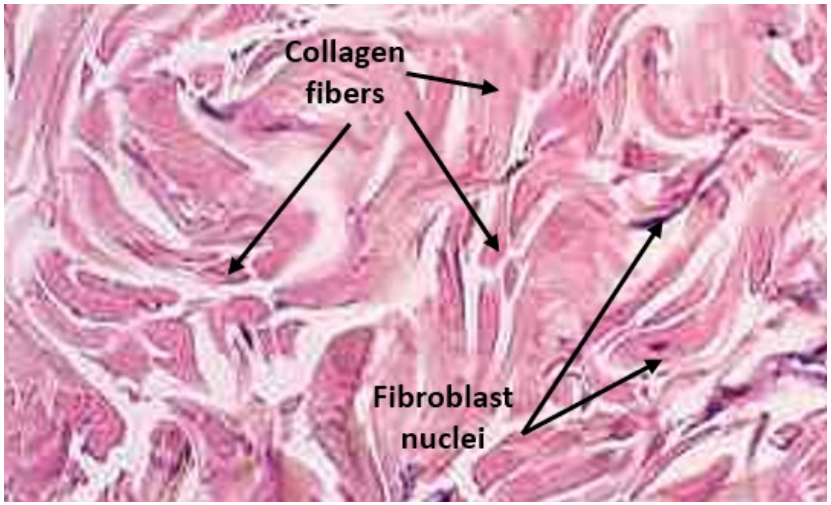
Reticular Tissue



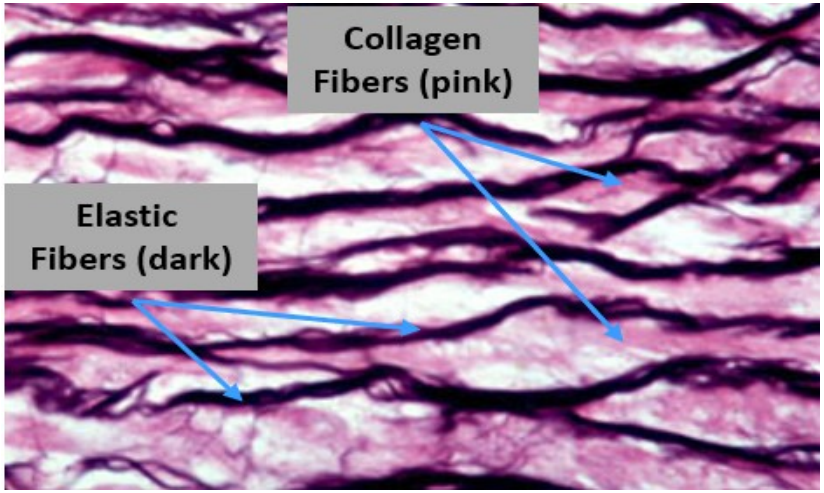
Dense Regular CT



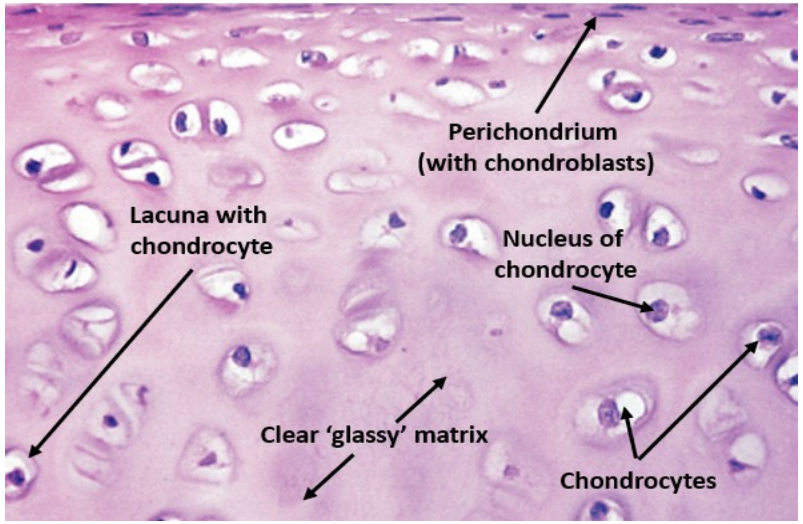
Dense Irregular CT



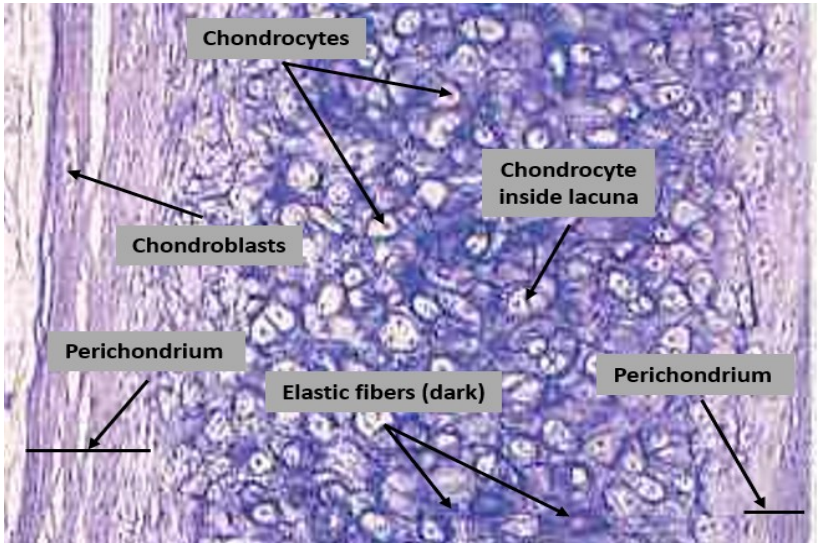
Elastic Tissue



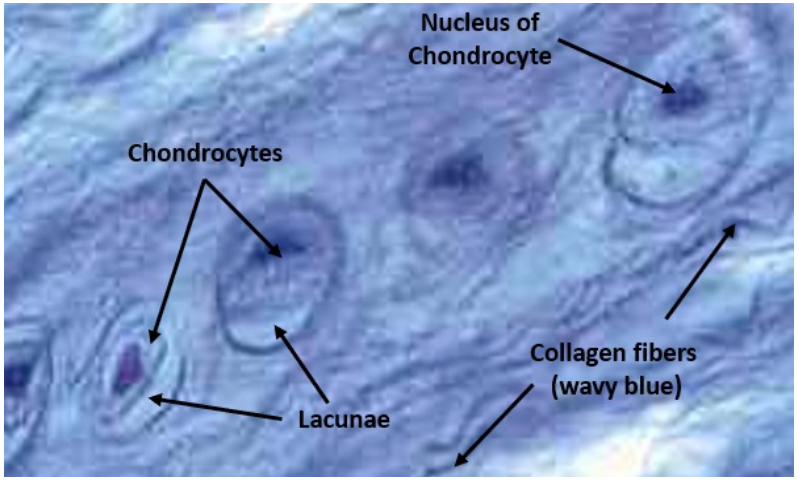
Hyaline Cartilage



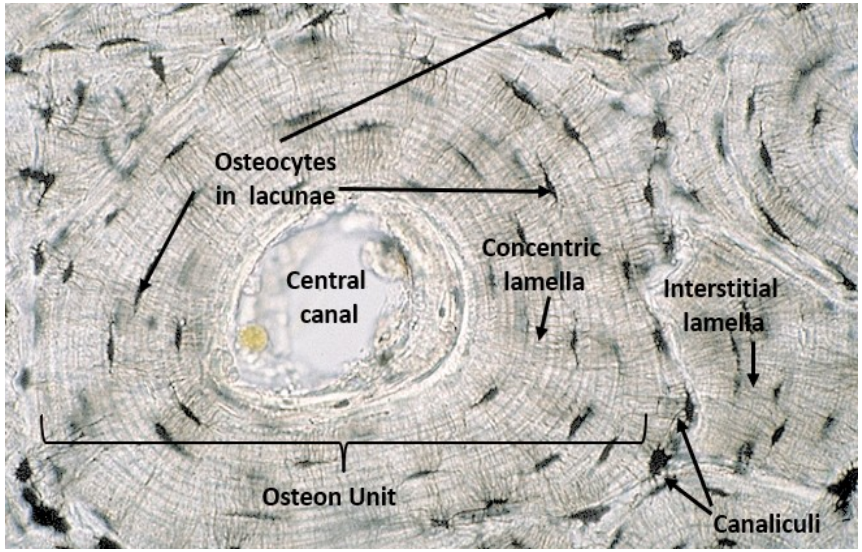
Elastic Cartilage



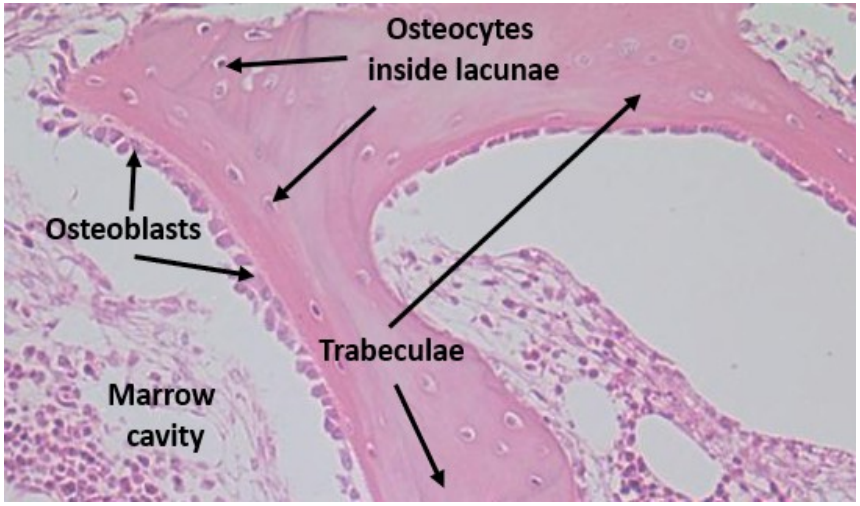
Fibrocartilage



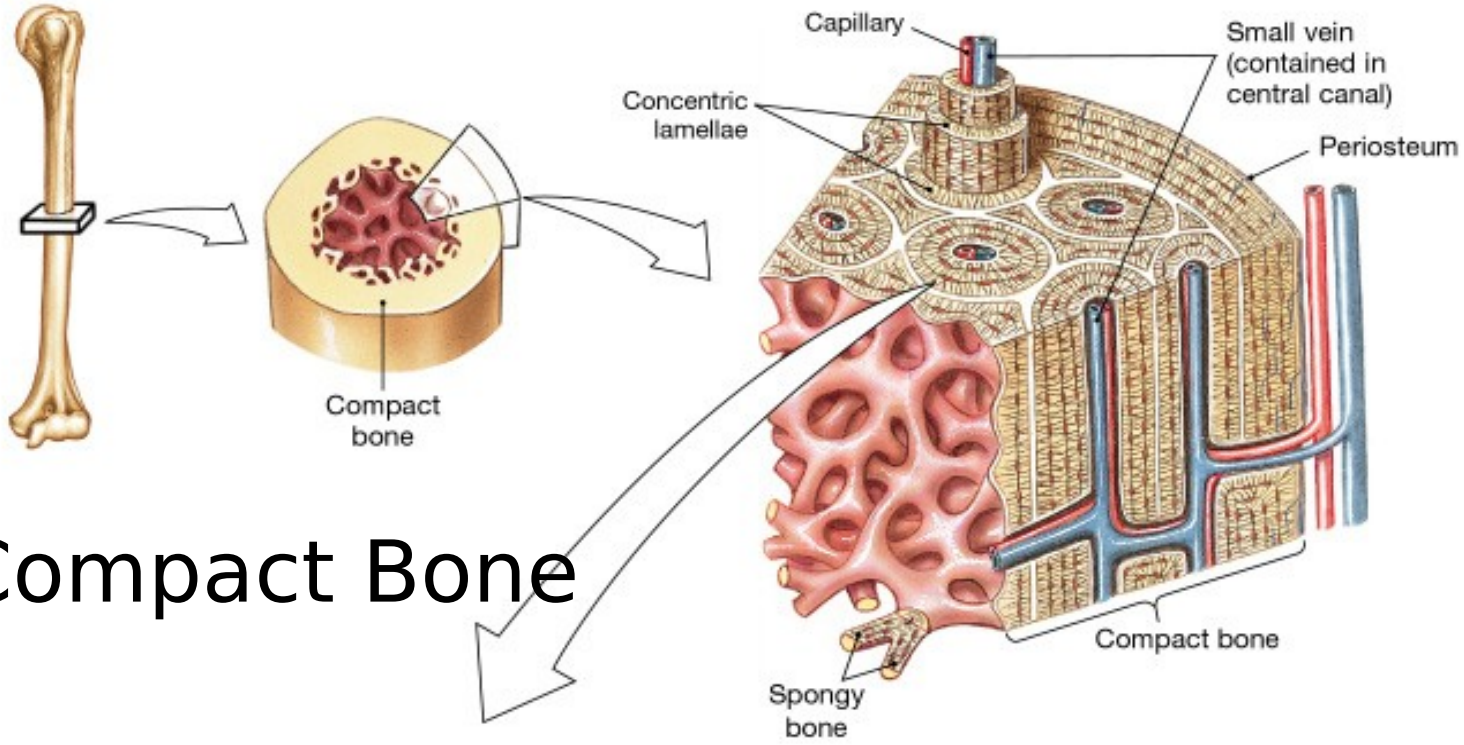
Compact Bone



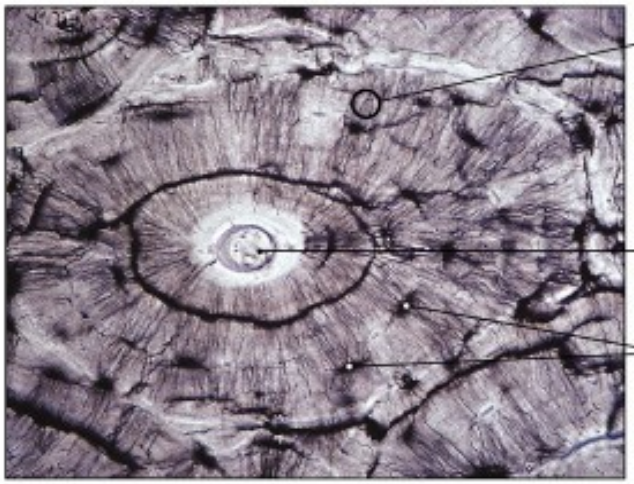
Spongy Bone

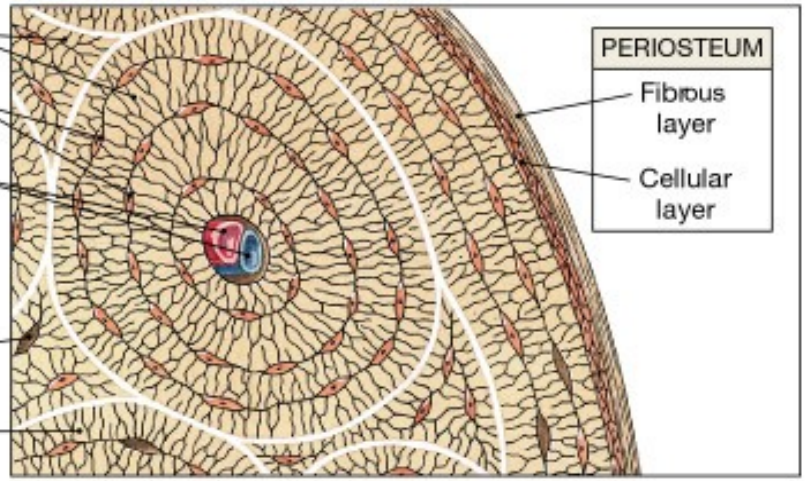


Bone Tissue

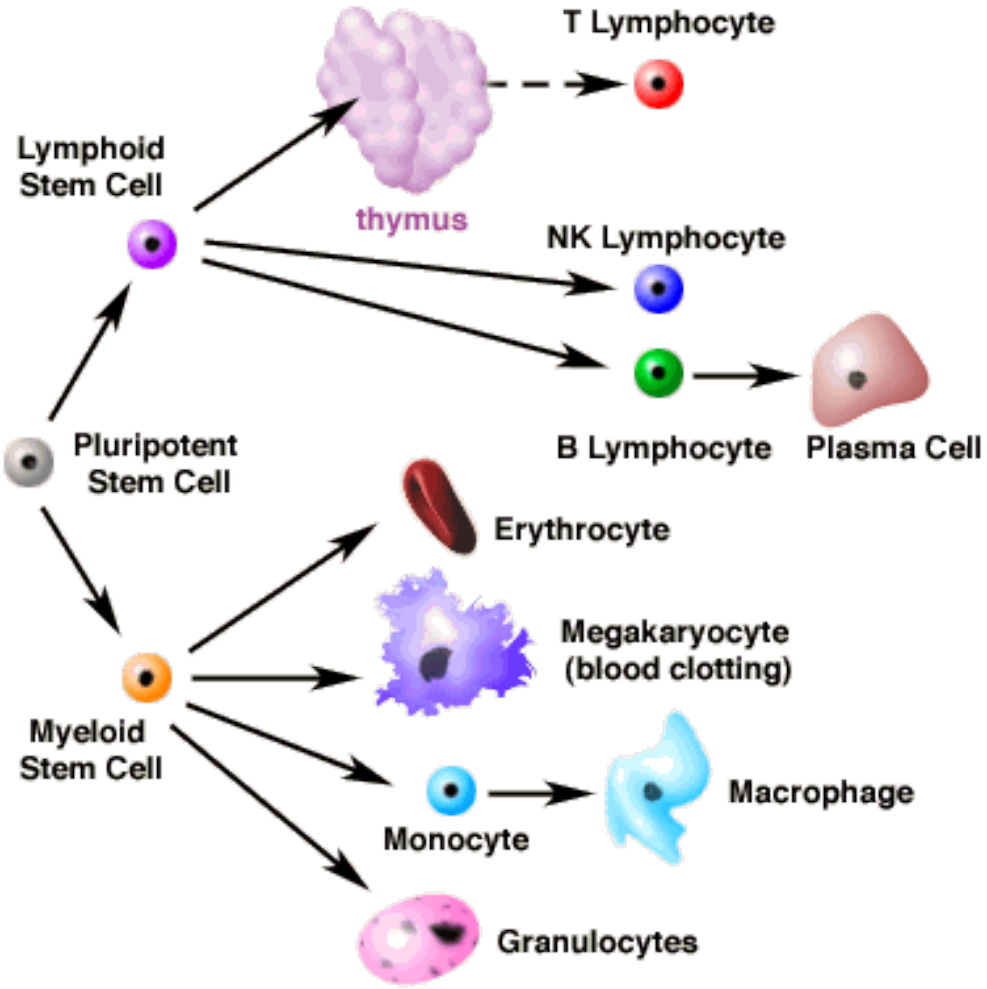


Compact Bone



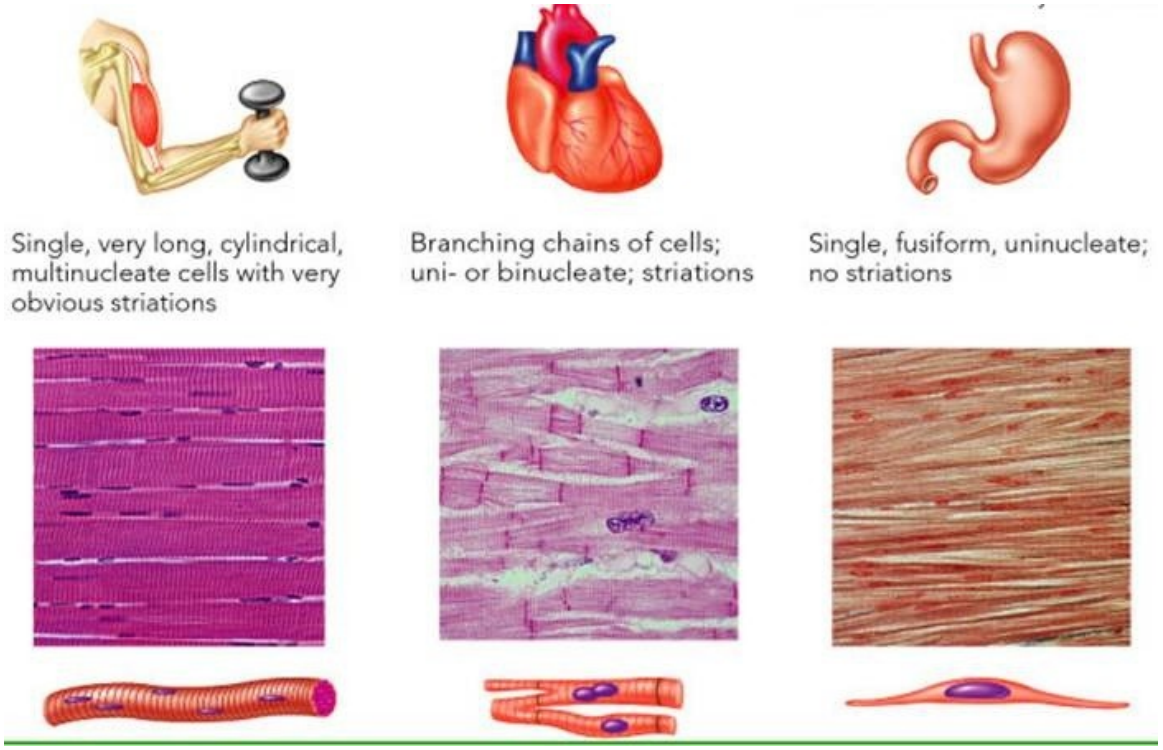


Fluid Connective Tissue



Hematopoietic stem cells produce blood and lymph cells

Muscle Tissue


Single, very long, cylindrical, multinucleate cells with very obvious striations
Branching chains of cells; uni- or binucleate; striations
Single, fusiform, uninucleate; no striations

Skeletal

Cardiac

Smooth

Nervous Tissue

Neurons
and
Glial cells